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lectures before farmers' organizations have been delivered since the College was established, but they certainly number several thousand. In addition to all this, the College has done a vast work in helping the farmers out of their difficulties by personal correspondence. From five to ten thousand letters per year in answer to questions are written by the staff. This work alone is a great tax upon the College, but the benefits derived are so great that the practice still continues of answering, to the best of our ability, all questions related to agriculture, directly or remotely.

"The Experiment Station, a department of the College of Agriculture, has published 196 bulletins, in editions averaging more than 20,000 each, and fourteen annual reports. Whenever there is a serious outbreak of insects or fungi, a specialist is dispatched immediately to make investigations and to help overcome the difficulty. \* \* \*

"Agricultural students have gone to all parts of the State and carried with them the light of science to aid the farmer in his arduous and difficult, though independent and noble, calling. Professors, by their investigations on the diseases that attack grains and fruits and flocks and herds, have saved millions of dollars to the State. The Cornell method of combating the pear-sylla saved over a million dollars to a single county. Methods of orcharding have added noticeably to the prosperity of farmers and fruit growers."

CORNELL UNIVERSITY. R. H. THURSTON.

#### SCIENTIFIC BOOKS.

*Die heterogenen Gleichgewichte, vom Standpunkte der Phasenlehre.* Erstes Heft: *Die Phasenlehre: Systeme aus einer Komponente.* By H. W. BAKHUIS ROOZEBOOM. Braunschweig, Friedrich Vieweg und Sohn. 1901. 14x22 cm. Pp. xiii+217. Price, paper, 5.50 Marks.

Every one who lectures on a subject feels the necessity of presenting it, so far as may be, in a systematic, coherent manner. For this reason we make the 'periodic law' the basis of lectures on inorganic chemistry, while we classify organic substances according to their constitution formulas. In physical chemistry the order of treatment has been based largely on the physical state of the system, gaseous, liquid or solid. It is an open question whether the orthodox classification is or is not the best in the case of inorganic and organic chemistry; but it is certainly not satisfactory for physical chemistry. The ideal classification for this last subject is based on the phase rule of Willard Gibbs and depends primarily on the number of components and secondarily on the degrees of freedom. By the components we mean the substances from which the system can be made, and we classify our material first as one-component, two-component, three-component systems, and so on, usually grouping systems containing more than three components under the single head of multi-component systems. We next subdivide each group according to the degrees of freedom, this depending on the relation between the number of independently variable components and the number of phases. By phases we mean the physically distinct portions of the system, such as the solution or liquid phase, the vapor phase, the solid phase or phases. When the only factors to be considered with relation to equilibrium are the pressure, temperature and the relative masses of the components, the state of the system is fixed when there are two more phases than there are components. Such a system is called an invariant system. When there is only one more phase than there are components, the system is called a univariant system, and it is said to have one degree of freedom because the state is not fixed until we settle arbitrarily the value of one of the independent variables. When the number of phases equals the number of components, the system is a divariant one having two degrees of freedom. Each decrease in the number of phases means an equal increase in the degrees of freedom.

The classification according to components and degrees of freedom is known as the phase-rule classification. It is broad enough to include all facts pertaining to equilibrium and yet clearly enough defined so that everything has its own place. It is therefore an ideal classification, or perhaps the ideal classification for chemical equilibrium. It is more comprehensive than the periodic law or constitution formulas, and chemistry as a whole will some day be presented from this point of view. The phase rule is to the science of chemistry what the steel frame is to a building, the periodic law, constitution formulas, the mass law, the laws of electrochemistry, etc., being the brick walls. Just as we can build a small building safely of bricks and wood, while the steel construction is the only wise one for a sky scraper, so we have managed to get along satisfactorily hitherto without the phase-rule classification; but the rapid development of quantitative chemistry necessitates a new arrangement.

The book by Professor Roozeboom does not claim to revolutionize chemistry in the manner just outlined. Our ignorance is still too great to permit such a scheme being carried through to-day, though the direction in which we are tending and must tend is very clear. This book deals chiefly with the qualitative side of equilibrium and this first volume with systems containing one component only. It is, however, a conscious and deliberate step in the direction of the goal I have indicated and no one is better qualified to take this step than Roozeboom. We owe the phase rule to Gibbs; but it was Roozeboom who brought out the significance of it; who changed it from an interesting but apparently unimportant mathematical generalization to the safe guide in all matters of equilibrium and to the future basis of systematic chemistry. In this first volume the author begins with the discussion of the boundary curves for liquid and vapor, solid and vapor, solid and liquid. The triple point at the intersection of these three curves is next considered. We then pass back to the equilibrium between two stable solid phases and to the triple point with solid, solid and vapor in equilibrium. A

chapter on flowing crystals follows, in which it is shown that these are properly to be considered as a solid phase and that the first inversion point is one for solid, solid and vapor. Next comes a chapter on instable triple points in the case of enantiotropic systems, and then one on the behavior of monotropic substances. The volume closes with a chapter on the triple point, solid, solid liquid; one on the triple point, solid, solid, solid; and a final chapter in which the general question of uniform and non-uniform pressure is considered.

WILDER D. BANCROFT.

*Die wissenschaftlichen Grundlagen der analytischen Chemie, elementar dargestellt.* Von W. OSTWALD. Dritte, vermehrte Auflage. Leipzig, Wilhelm Engelmann. 1901. 13x21 cm. Pp. xi+221. Price, bound, 7 Marks.

The book is divided into two nearly equal parts, the first containing general theory and the second the application. The first chapter deals with the conditions for recognizing a substance and might well have been fuller. When two or more properties of two substances coincide, the other properties usually do and the substances are identical. This is true, but not complete. For instance, the converse does not follow. We can have substances, notably some of the radio-active substances where certain properties can differ markedly and yet the two substances be the same from a chemical point of view. This raises the question as to what properties, if any, are to be considered fundamental.

The second chapter gives the methods of mechanical separation, together with the theory of washing a precipitate. The third chapter treats of separation by distillation or solution. The fourth chapter is devoted to the electrolytic dissociation theory and the fifth to the question of measurement. In the second portion of the book the author takes up the different elements in the usual analytical groups and discusses them. In an appendix are given a number of interesting lecture experiments.

The opinion one forms of this book will depend on one's point of view. If one looks upon it as a book for those beginning analyt-